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AUTHOR Hitchcock, Susan Tyler
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ABSTRACT

This companion document updates an April 1998 volume on designing schools to use solar energy as a power source. Volume 2 presents numerous case studies of solar installations in new and existing schools across the United States and Europe, updates and presents new examples of solar education programs, and offers an updated resource listing of organizations and programs that can provide information and assistance for solar school projects. A list of solar power resources on the Internet is included. (GR)

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SchoolsGoingSolar

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ED 461 252

Volume 2

A Guide to Schools Enjoying the Power of Solar Energy

EF 006 035

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Schools Going **Solar**

Volume 2

A Guide to Schools Enjoying the Power of Solar Energy

Produced by the Utility PhotoVoltaic Group
Bob Gibson, Editor
Seth Kalish, Design and Layout
Jacquie Bokow, Contributing Editor
Susan Tyler Hitchcock, Writer

Additional research and writing by Peter Slavin, Liz Milner, and Bruce Millar. Thank you to the many individuals and organizations that provided information and photographs for this publication.

Cover photo: Brooklyn students at a New York Power Authority solar installation by Wendy Bensley/UPVG.

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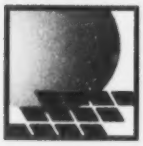

Utility PhotoVoltaic Group

Schools Going Solar, *Volume 2, is a product of the* ***Utility PhotoVoltaic Group*** *(UPVG): 150 organizations—led by 100 electric service providers from seven countries—working together to advance the use of solar photovoltaic power. The nonprofit association receives funding from the U.S. Department of Energy to support* TEAM-UP *(Technology Experience to Accelerate Markets in Utility PhotoVoltaics), a program to put photovoltaics to work in applications that have the strong potential to develop into mainstream use.*

The UPVG also provides information on market developments to its members and the general public.

Going *Solar*

The UPVG produces ***Schools Going Solar*** *as part of its participation in the* ***Going Solar*** *campaign. Going Solar is led by the* **Interstate Renewable Energy Council** *(IREC) and includes the* **American Solar Energy Society** *(ASES).*

UPVG

IREC

ASES

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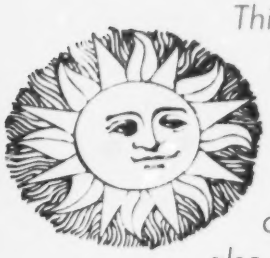
Schools *Going* ***Solar***

Volume 2

Introduction



This publication is an update of, and a companion to, the first volume of Schools Going Solar, which we published in April 1998. Since that time, we have received a steady stream of calls from school systems, utilities, and architects interested in learning more about how schools can go solar, along with calls from reporters looking for leads on this new "trend." We also have collected reports on scores of new solar energy installations in schools. Solar on school rooftops is making a notable contribution to the President's Million Solar Roofs Initiative.

In Volume Two we've added more information on the pragmatic questions surrounding the decision to go solar. It is important to put solar energy use in context. In many cases, solar energy cannot substitute for traditional energy sources in terms of immediate savings. There are many practical issues of siting and installation to consider in order to achieve a successful, satisfying solar project. And in financing solar installations, in particular active solar technologies, traditional funding channels and mechanisms may not be sufficient.

But designing schools to make use of solar energy, and combining solar with other energy efficiency measures, makes great sense. The growing popularity of installations of solar photovoltaic power is a reflection of the attitude of utilities, schools, and communities in all regions of the U.S. and around the world towards solar energy. There is widespread belief in the immediate educational benefits of going solar and a conviction that today's investment will return a long-term payoff in development of a technology of local and global significance.

In Volume Two, we present more case studies of solar installations in new and existing schools across the U.S. and in Europe, updated and new examples of solar education programs, and an updated resource listing of organizations and programs that can provide information and assistance with solar school projects.

Our thanks to Jane Weissman of the Interstate Renewable Energy Council (IREC) for inspiring the launch and expansion of Schools Going Solar.

Bob Gibson

Editor, *Schools Going Solar*

Utility PhotoVoltaic Group

Solar ABCs

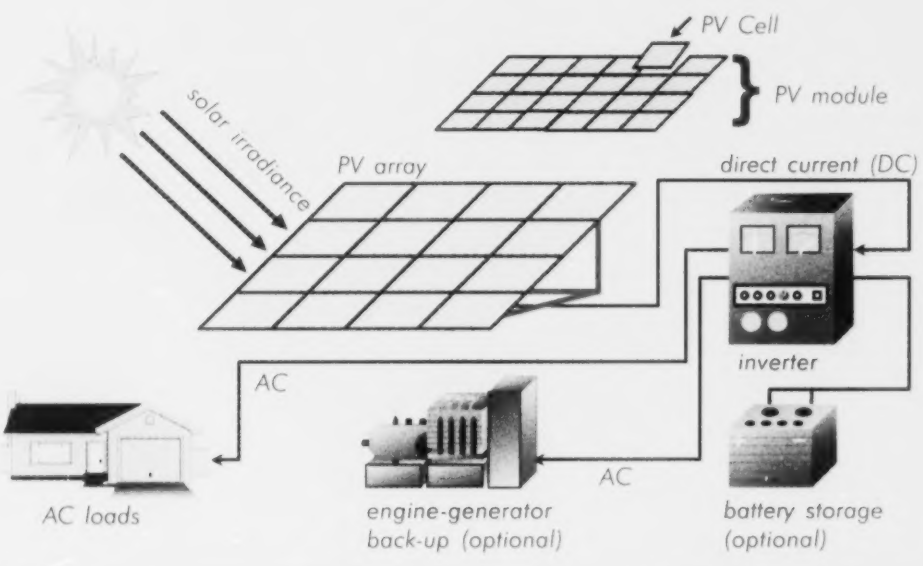
Photovoltaics — Electricity from the Sun

Photovoltaic cells convert sunlight directly into electricity; they have no moving parts. When sunlight strikes a PV cell, an electron is dislodged. (PV cells are usually made of silicon that's been chemically treated; silicon is the same stuff as sand at the beach and is found all over the world.)

These loose electrons are gathered by wires attached to the cell, forming an electrical current. The more cells, the greater the current and voltage. A number of PV cells laid side-by-side form a rectangular "module"; several modules together form an "array."

PV systems are already part of our lives. The smallest systems power calculators and wrist watches. Larger systems provide electricity for water pumps, highway signs, communications equipment, satellites, mobile homes, medical purposes (to power medical equipment, water purifiers, and refrigerators holding vaccines), navigation buoys, streetlights, and even for lighting homes and running appliances. In a surprising number of cases, PV power is the cheapest form of electricity for performing these tasks, far cheaper than running electric lines to remote areas. The largest installations—huge fields or entire rooftops of PV— have been erected by utilities and government agencies to create "solar electric power plants."

Diagram of a Typical Photovoltaic (PV) System



Passive Solar — Simple, Elegant, Smart

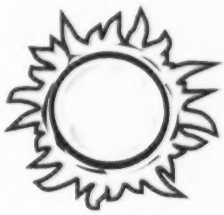
"Passive" Solar uses the sun for lighting and its warmth for heating without the aid of a mechanical device (no switches, pumps, fans, or wires). Passive Solar technologies save energy because less energy is needed for lighting and heating when the sun pitches in.

Tests conducted by the National Renewable Energy Laboratory show that buildings with passive solar design use 47 percent less energy than conventional new buildings and 60 percent less than comparable older buildings.

There are four main types of passive solar design for buildings: direct gain, mass-wall, sunspace, and daylighting. In *direct gain*, sunlight heats tiled or concrete floors; later, the accumulated heat is radiated back into the room. The *mass-wall* system puts a wall of concrete, brick, or containers of water behind south-facing windows. The wall materials absorb the heat; the heat then is released slowly after the sun sets. *Sunspaces* (much like greenhouses inside or attached to a building) use glass walls or ceilings to gain as much heat from the sun as possible and are especially useful in colder climates, where they're used in conjunction with direct gain and mass-wall systems. *Daylighting* is used most widely in larger buildings, like schools and offices, to admit sunlight without its heat. Because daylighting reduces the use of electrical lights, which can be dimmed or turned off, and the heat they produce, the need for cooling is reduced, too, so air conditioning systems can be smaller, saving energy again and again every summer.

Buildings employing passive solar design might include skylights, uncovered "clerestory" windows high across a wall to increase the amount of light inside, "light shelves" along high windows to "bounce" sunlight into the darker interior, broad eaves overhanging windows to keep out the hot summer sun when it is high in the sky, systems to hold water on rooftops where it can be heated by the sun, and tile-covered or stone interior walls or floors to "soak up the sun."

Solar Thermal — Heat Without Combustion



Solar Thermal systems collect the heat from sunlight to produce hot water for kitchens, restrooms, locker-room showers, or swimming pools; heat for buildings; or electric power.

Applications range from simple pool water heating systems to multimegawatt electricity generating stations. Solar Thermal differs from Passive Solar in that a mechanical device such as a pump or fan is used to distribute the heated water or air throughout the building.

Low-temperature systems are most commonly used to heat water for swimming pools. Usually, it's a black plastic sheet imbedded with tubing through which water is circulated and then returned to the pool.

Medium-temperature systems heat either air or liquid and are used to provide space, water, and process heating for homes and businesses; domestic hot water systems are the most common example. Unlike pool-heating systems, these nearly always have a conventional backup (i.e., gas or electric), as the water needs

to stay at least at a certain temperature whether the sun is shining or not. These usually consist of flat-plate collectors: large, flat boxes that are dark inside, with one or more glass covers. Air or a liquid, such as water, flows through tubes inside the box and is warmed by the heat that builds up inside the plates. (Here's where it gets tricky: some types of Solar Thermal collectors also can be considered Passive Solar if they use design features and natural ventilation—not pumps or fans—to transport heat.)

High-temperature Solar Thermal technologies work by using mirrors and lenses to concentrate large amounts of sunlight onto a smaller area (the "receiver") to achieve high temperatures. Unlike the low- and medium-temperature Solar Thermal systems, high-temperature systems (also called concentrating solar collectors) generate electricity. But, unlike solar cells, which use *light* to produce electricity, concentrating solar power systems generate electricity with *heat*. The three types of high-temperature solar thermal systems —all used to generate electricity—are the parabolic trough, central receivers, and dish/steam engines.

The parabolic trough focuses sunlight on a tube that carries a heat-absorbing fluid, usually oil. Central-receiver systems (or "power towers") use fields of mirrors to focus the sun's energy on one spot atop a tower. In the tower, water or molten salt is heated. In these two cases, the hot fluid is circulated through a boiler filled with water, turning it to steam, which is routed to a turbine to generate electricity. The dish/Stirling engine system uses a parabolic concentrator (dish) which tracks the sun and reflects the sunlight onto a receiver filled with fluid (often liquid sodium), which is heated. A Stirling engine can be powered by this heat.

Practical Questions: What You Need To Know About Going Solar

Like any other complex project, retrofitting a school with solar presents a long list of decisions—some technical, some political, all interdependent.

What's it for?

"First the school has to decide whether this is primarily a system to save money or a system to teach solar energy principles," says David Watkins of Reliable Energy Systems in Charlottesville, Virginia. For less up-front money and with a shorter pay-back schedule, solar thermal systems to heat water are the best retrofit choice for a school that wants to see savings on energy right away. At the price that most schools can afford, photovoltaic systems will produce only a fraction of their energy needs, but they can be configured with meters or read-out panels, data acquisition software on a computer, and Internet links to other PV systems, to provide a multifaceted set of solar energy lessons for every classroom level.

Where should it go?

Most PV arrays will be mounted on racks that attach to or rest upon the roofs of school buildings. A southern or southwestern exposure works the best, with little or no shading from nearby trees or buildings. "We had one school that wanted solar so much, they were willing to cut down a stand of pine trees right next to the school," says Chip Bircher of the Wisconsin Public Service Corporation. "We didn't think they should do that."

"Despite the obvious requirements that the system be facing solar south and be unobstructed," says Richard Eidlin of Solar Works in Wilton, New Hampshire, "the actual location is often a function of who within the school is guiding the process. Some principals and school board officials want their system to stand front-and-center in public view, as an advertisement for environmental awareness. Others see the solar panels as an eyesore, or fear their neighbors will, so they request a less conspicuous setting."

While the principal at Silver Spring, Maryland's Pinecrest Elementary vetoed the PTA's request to install PV panels atop the weatherproof walkway right at the front of the school, she is allowing the rooftop rack to be raised a few feet above its four-foot knee wall to make it more visible to the community.

"We had one school that wanted solar so much, they were willing to cut down a stand of pine trees right next to the school," says Chip Bircher. "We didn't think they should do that."

While most people presume that photovoltaics will be mounted on the roof, out of sight and out of the reach of vandals, there may be reasons to consider other locations. JEA's Larry Wagner reports that in Jacksonville, Florida, so many school roofs leak that many are removing air conditioning units from them. For those schools, free-standing elevated racks might work better, although Wagner recommends that the lowest edge stand at least 11 feet from the ground, "to keep the basketball players off it."

In Hawaii, Art Seki of Hawaiian Electric says the utilities installing PV under its Sun Power for Schools program have by-and-large sought out roof spaces that sheltered walkways or other nonessential spaces. "We have looked for accessible but secured roofs that allow the panels to be seen from the ground and that aren't over classrooms or spaces where school officials might be nervous about leaks, " he says.

What will it do to the building?

Schools considering roof-mounting their solar array should think through the impact of the system on the roof of the school building. "You need to look at the type of roof you have. Does altering the roof void any warranties?" says Stephen Barkaszi of the Florida Solar Energy Center. "Consider the roof's existing condition. If you're going to have to replace your school roof in the next few years, you shouldn't put a PV system on it that you hope to keep operating for 25." Likewise, sponsors should ascertain through community contacts, suggests Chip Bircher, that the building is indeed guaranteed to remain in use as a school for at least the next 10 years.

Fifteen years ago, a roof-mounted PV system would likely be bolted right into the structural beams of the roof. Today, PV systems generally have a lighter tread and minimal roof penetrations. Ascension Technology of Massachusetts has installed a number of utility solar school systems as part of the UPVG's *TEAM-UP* program, using a ballasted tray to hold the PV securely on the roof with no penetrations. PowerLight systems incorporate PV into the skin of the roof by layering PV cells onto styrofoam panels, which are both lightweight and insulating.

State law may require structural engineering inspections of a system added to the roof. In Maryland, for example, to meet state requirements, Jonathon Cross had to hire an independent Professional Engineer to perform a structural analysis of the roof-mounting system designed for Pinecrest Elementary in Silver Spring. "Some installers have access to this type of service — a specialized P.E. with training in structural analysis on their staff," says Cross. He recommends that schools avoid additional costs by working with an organization that includes someone capable of doing such an analysis.

Who should be involved?

The more individuals and organizations in on the decision making process the better, and the earlier the better, says Chip Bircher. "The key is to get everyone involved and informed." Architects, roofers, school maintenance staff, electricians, school administrators, school board members, even the school's PTA — everyone has a part to play, and everyone should be well informed from start to finish.

Engaging and educating the maintenance staff within the school building is a critical step in the process. "As we have talked with school staffs, we have had the whole range of reactions," says Bircher, "from 'Why are you here and what are you doing?' to 'How can I help?'"

With so many interests involved, however, it is critical that a single office or individual orchestrates the entire project. In some states, that person represents the utility. Elsewhere, it's someone from the state energy office. Some private companies, like Solar Works in New England or Innovative Design in North Carolina, offer management services that span the full spectrum needed to help a school go solar. "The school needs someone who is really going to champion the project," says Chip Bircher. In some cases, as in the example of Charlie Garlow at Pinecrest Elementary in Maryland, it might even be a parent, passionate about the community's energy future and willing to volunteer time and effort.

Totally Awesome! Building Better Schools, Healthier Environments

When the Four Oaks Elementary School in Johnston County, North Carolina, burned down in 1990, architects at Innovative Design saw an opportunity. They came up with a design for rebuilding a school that ten years ago was unusual, even outlandish: a design that maximized interior daylight for the sake of saving energy.

"At first we never could convince the engineers that daylighting would decrease the mechanical load," says architect Michael H. Nicklas, co-owner with Gary B. Bailey of Innovative Design in Raleigh, N.C. "We kept asking ourselves, is this thing really going to work?"

But the Johnston County school system went with the plan, and in the years to come, the idea has proved itself. The building was designed with vertical view glass and south-facing roof monitors, providing indirect daylight into every single room. Properly sized overhangs shaded the vertical glass during warm months, while passive solar gain boosted the heating system in the winter. The building came in more than $300,000 under budget and has saved on heating and cooling ever since.

Since 1990, Innovative Design has had a hand in the design and construction of 17 more school buildings, incorporating daylighting into every one. "There's a common thread that we knew was a winner," says Nicklas. "You get that daylighting in and it will pay for everything else."

Daylit designs reduce mechanical loads by ensuring that the space inside a school building stays cooler. "Natural light is cooler than incandescent light by a third," says Nicklas. In North Carolina, where many schools operate on a year-round schedule, air conditioning is the highest energy-consuming system of all. Daylighting reduces the need for electrical lighting as well, which also contributes to energy savings.

A daylit design is the one energy-saving feature that can make a school cost less from the day it is built, says Nicklas. Other features, as valuable as they may be, pay back over years. Nicklas estimates that daylighting pays back over zero to two years. A solar hot water system in a school pays back over seven to 10 years; a photovoltaic power system pays back in 18 to 20 years.

Nicklas grants that many view the energy savings promised by these designs with skepticism at first, particularly the engineers who design the mechanical systems and the plant managers who will operate them.

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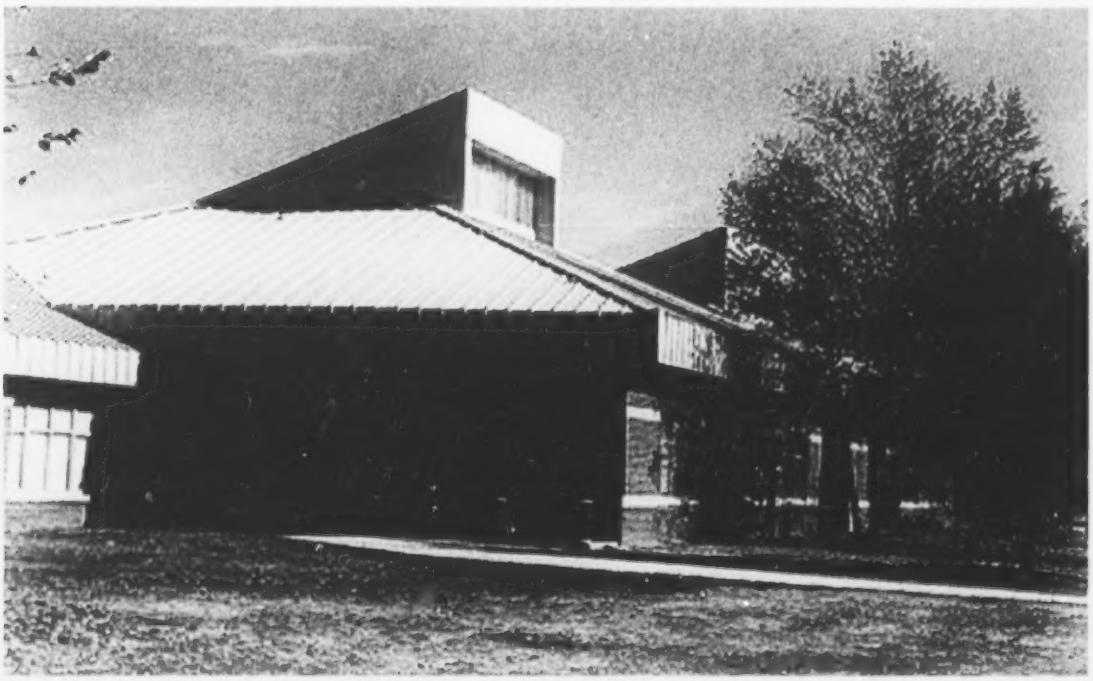


But Nicklas' firm has prepared studies showing that in one North Carolina middle school, for example, of the $230,000 added to building costs for daylighting, $115,000 was gained back in downsized mechanical and electrical systems. Comparing energy use for a year between daylit and conventionally designed school buildings, Innovative Design calculated that the daylit school buildings achieved an average annual savings of $40,000, even in a year with less than average sunshine during the heating system.

Most people, when they imagine a school designed for daylighting, mistakenly think windows, Nicklas says. But modern daylit schools depend upon baffles, roof monitors, and clerestory structures, not just eye-level windows. The design must bring in diffuse light, not direct sunlight which adds heat.. "There's no glare, no direct beam, no light shining on the face of people inside," says Nicklas.

Photovoltaic systems lend themselves to classroom displays and student interaction, while daylighting is harder to comprehend and turn into a science or math experiment. As much as possible, Nicklas and Bailey encourage the schools they work with to incorporate an interconnected array of renewable energy designs and systems into their landscaping and architectural plans.

"What we're trying to push is the whole concept of sustainable schools. We see it as a teaching package," says Nicklas. "You have to get to people philosophically."

The Light of Day: Smart Stuff

When the California Board for Energy Efficiency analyzed test scores of over 21,000 students, they found that students with the most daylighting in their classrooms progressed 20 percent faster in math and 26 percent faster in reading than those with the least daylighting. Students in classrooms with the largest window area progressed 15 percent faster in math and 23 percent faster in reading than those with the least window area. Students in rooms with diffuse light from an operable skylight progressed 19 percent to 20 percent faster than those in rooms without a skylight.

The rewards that come from daylighting schools go way beyond the monetary. Studies suggest that at daylit schools children grow taller, concentrate better, score higher on standardized tests, miss school less often, and even develop nine times less tooth decay.

And they live in the middle of a working model of renewable energy. Put to good use through the help of engaged teachers, a building that includes daylighting, photovoltaics, and other energy-conscious design features can serve as a classroom and laboratory for years to come. Convince the children of the value of solar energy, and they will carry the message to the community.

"Totally awesome!" one student at Four Oaks Elementary commented of his new school. "This place is so nice I wouldn't mind having one for my home."

Contact: Mike Nicklas, Innovative Design, Raleigh, NC, 919.832.6303.

Performance Contracting: A Promising Means to Finance Solar Schools

Paying for the addition of a solar energy system on a new or existing school is a challenge. When considered in isolation, the full, up-front costs of a photovoltaic system and even a solar thermal system are more than many school districts feel they can afford.

The majority of the PV installations included in the first two volumes of *Schools Going Solar* have received subsidies in the form of federal dollars (largely through the Utility PhotoVoltaic Group-managed *TEAM-UP* program), state and community grants, public funds collected on a statewide basis from utility customers, or contributions from utility customers through green pricing programs.

To funded expanded use of solar in schools, other funding mechanisms are needed. A promising avenue is to reduce energy consumption through more efficient use of energy, and to re-invest some of those savings in solar systems.

At Edwards Air Force Base in California, Roy Johannesen, Honeywell Corporation's Energy Retrofit Solution Development Manager for northern California, is looking to turn dollars from energy service performance contracting conducted by his company into solar investments in the surrounding Muroc School District. At Honeywell, Johannesen has introduced elements of a utility-focused Solar for Schools program he developed previously in Florida.

"The school district has indicated a strong interest in solar energy," says Johannesen. "It has recently installed an Internet-based wide area network that is ideal to support the financial transactions and the educational component of a performance-based Solar for Schools program."

Ideally, the energy retrofit installations at schools that save energy, such as more efficient lighting and air-conditioning, are self-funding. As a part of the performance contracting within a school district, local homeowners and businesses will participate in the energy-saving retrofits. A portion of the resulting savings, which formerly would have been paid by individuals to their utility, will now be voluntarily donated to the schools to support solar installations and education activities.

Johannesen estimates that a Solar for Schools performance contract can add 30 to 40 percent to the cash flow achieved under a standard performance contract. For example, under a typical $1 million contract lasting 10 years, "we think we can bring $300,000 to $400,000 more benefit to that school over the life of the Performance Contract in the form of additional solar installations, the procurement of state-of-the-art computer systems, and a simple, practical and effective way to teach advanced solar-related technology to interested students," he says.

While a University of Florida professor during the mid-1990s, Johannesen developed a showcase of solar technologies at Ferry Pass Middle School in Pensacola, Florida (see *Schools Going Solar, Volume One*). These installations and companion education program were field demonstrations of an energy service and education program originally designed for electric utilities known as Solar for Schools. The results of that demonstration can be found on the web site of the SolMates Foundation (www.SolMates.org).

Contact: Roy Johannesen, Honeywell Corporation, 530.637.9516. E-mail: Rjohann710@aol.com.

Where It's Working: Elementary and Secondary Schools

Public and Private Partners Bring Solar to New Hampshire Schools

Solar power will be part of the everyday vocabulary of students in four New Hampshire high schools starting this year, thanks to a Solar on Schools program developed by the Governor's Office of Energy and Community Services, Public Service of New Hampshire, and the Wilton branch of Solar Works.

New Hampshire Governor Jeanne Shaheen calls the program "a perfect example of a public-private partnership that benefits our schools, educates our children and the public . . . and at the same time helps the environment."

Governor Jeanne Shaheen launches Solar on Schools.

Hopkinton, John Stark, Newmarket, and Kennett High Schools have each been equipped with two-kilowatt photovoltaic systems, expected to generate over 2,800 kilowatt-hours a year of electricity. Operational data from the photovoltaics comes into the school buildings, reading out on monitors and manipulable on PCs in the classroom.

In Will Renauld's pre-engineering labs at Hopkinton High School, for example, electronics students will analyze the system's inverter technology and the methods used to tie the photovoltaics in to the electricity grid. Math students will collect data from the photovoltaics and use those numbers for real-life analysis of energy flow and usage. Business students will help plan and organize a community open house, designed to introduce the solar energy system and its potential to the larger Hopkinton population.

Installation of the PV system at Newmarket Junior and Senior High.

All four schools have promised an interdisciplinary approach and a community open house, both strategies designed by the Office of Energy to be sure that these photovoltaic installations get the renewable energy message out to the whole community.

Career education and community service are important aspects of high school programming today, says Robin Read, New Hampshire's Energy Program Manager. "All of these kinds of programs lend themselves to Solar on Schools."

This year's systems were funded by Public Service of New Hampshire, the state's largest electric utility, and from oil overcharge monies received by New Hampshire as part of federal oil price-fixing settlements. Next year, hopes Read, private donors will join local utilities in helping to put more photovoltaics on more high school roofs.

Contact: Robin Read, Governor's Office of Energy & Community Service, 603.271.2611.

Vermont High School Adds PV, Commits to Energy Efficiency

In Vermont, Solar Works has installed a two-kilowatt photovoltaic system at the Cabot School, a public high school in the town of Cabot, the first of two school systems planned to be up and running in that state in the fall of 1999.

Leigh Seddon and students assemble panels.

Green Mountain Energy Resources (GMER), a residential electricity marketer that specializes in renewable energy resources, provided primary funding for the Cabot School system. In addition, the State Department of Education and the Vermont Energy Education Program worked with Solar Works to develop and support the program.

Cabot School PV in place.

In order to qualify for the system, the Cabot School assembled an interdisciplinary faculty team dedicated to spreading the word on solar energy to every student. The school also agreed to implement a comprehensive energy-efficiency program in their plant over the next two years, with biennial reports submitted to the Vermont Department of Public Service. Finally, the school contributed $500 to the system cost.

Contact: Richard Eidlin, Solar Works, 603.654.6619.

Rhode Island's SunRIse Primes the Pump

Rhode Island's Project SunRIse sponsored a 250-watt system in a technical education classroom at Woonsocket High School in 1998, and a two-kilowatt system on the engineering building at Roger Williams University in Bristol. Solar Works, in partnership with the Rhode Island Renewable Energy Collaborative, coordinates funding, system design, and educational curriculum to insure that these two solar packages have the most impact on students and their communities.

For the Roger Williams University installation, local utility Narragansett Electric donated the equipment. So far no read-out capabilities have been established, but the wiring and meter sockets are there, waiting for funding or donations-in-kind to bring the information all the way into the engineering classroom.

At Woonsocket, meters display energy production right in the classroom. Recordkeeping functions at the utility itself provide the students with monthly computer data print-outs, organized in 15-minute intervals, so they can analyze the system's energy generation. "It might be enough to run the fluorescent lights in the classroom," says Bob Chew, director of the Solar Works Rhode Island office, who sees his work as "getting the pump primed" to find more individuals and organizations willing to help improve and increase reliance on solar energy throughout the state of Rhode Island.

Contact: Bob Chew, Solar Works, Inc., 401.245.8104.

City Solar Project Launched with System at Massachusetts High School

In February, an innovative city solar program in Medford, Massachusetts, was kicked off with the installation of a 1.9-kW system on Medford High School.

The Medford Solar Project is an initiative of Massachusetts Electric (a NEES company) and Ascension Technology to sell PV systems to residents of the suburban Boston community. The high school system, one of two demonstration sites installed to raise awareness about PV in the community, features a monitoring system that reads the solar production every 15 minutes. This fall, students will begin studying the PV system performance under the oversight of Mark Ryan, science director for the Medford school system.

Contact: Miles Russell at Ascension Technology by E-mail: mrussell@ascensiontech.com.

System Description for Medford

Go to http://209.21.219.20/upvg_sites_page.htm to track the performance of the PV system on Medford High School.

Utility	• NEES
System	• System AC Rating (PTC): 1.9kW
	• Type: Fixed
	• Array Tilt: 25.0°
	• Array Azimuth: 180.0°
	• Latitude: 42.4° N
	• Longitude: 71.1° W
PV Modules	• Module Manufacturer: ASE
	• Module Type: ASE-300-DG/50-285
	• Number of Modules in Array: 8
	• Array DC Rating (STC): 2.28kW
Inverters	• Inverter Manufacturer: Omnion
	• Inverter Model: 2400
	• Number of Inverters in System: 1
	• Total Inverter Nameplate Rating: 2.5kW

Connecticut Solar Schools Program Launched in Westport

When the Westport school board agreed to include a photovoltaic system on the town's new middle school, still on the drawing boards, some people asked, why no solar system for the old middle school? So now, once funding has been accomplished, both of Westport's middle schools will be equipped with two-panel, 500-watt photovoltaic systems. Northeast Utilities has agreed to fund one of the systems; advocates are currently approaching corporate and foundation donors to fund the other.

Architects were able to draw up plans for the new school to showcase the solar electrical system. The panels will be mounted on a vertical wall in a public courtyard, prominently displaying the school's decision to go solar.

By the middle of 2000, ten more PV systems should be up and running on Connecticut schools, thanks to the Solar for Connecticut Schools program, a statewide initiative to install photovoltaic systems on public schools throughout Connecticut. Each system is estimated to cost $18,000, of which a school must pay only $2,000, thanks to partnership and support from state agencies and private contractors and suppliers, including Solar Works, the United Illuminating Company, Advanced Energy Systems, AstroPower, Atlantic Energy, and the architecture firm of John Rountree. PACE, the People Actions for Clean Energy, Connecticut's largest all-volunteer organization working for renewable energy, also supports the project.

Contact: John Rountree, Solar for Connecticut Schools, 203.227.1766.

Solar Works Creates the Whole Package

Many believe in solar, but it takes more than believing to make it happen. In New England, Solar Works — active for 20 years in the solar industry — runs a Solar on Schools program, coordinating partnerships between the public and private sectors to bring solar electricity into the schools.

"We don't want a solar system to become just an interesting architectural feature," says Richard Eidlin, vice president for marketing at Solar Works. The company manages solar on schools initiatives through every phase, recruiting the schools, helping raise sponsorship monies, installing the PV systems, and providing a comprehensive educational package to help teachers bring solar into the classroom. Solar Works has established school systems in Vermont, Rhode Island, New Hampshire, and Connecticut, ranging in size from a 250-watt AC module to a 2-kilowatt ballasted tray roof-mounted system.

Contact: Richard Eidlin, Solar Works, 603.654-6619.

'Johnny Solarseeds' at Work in Maryland

In Maryland, if a school can raise $3,000 to go solar, the state's Energy Administration will match that, raise it another $1,000, and see to it that, for $7,000, the school gets a photovoltaic system and curriculum to match.

That total of $7,000 goes a long way, thanks to VASE, the Virginia Alliance for Solar Electricity, a partnership between Virginia Power, the U.S. Department of Energy, energy and technology offices from several mid-Atlantic states, and Solarex, a Frederick, Maryland-based PV manufacturer. Thanks to buy-downs extended to the schools through VASE, a PV kit including panels, inverter, wiring, and monitoring equipment comes to a total of under $5,000, with just over $2,000 budgeted for installation costs.

The 1.2-kilowatt systems generate about $15 to $20 per month in savings on a school's electricity bill, estimates Jonathon Cross of the Maryland Energy Administration. "That's a fraction of what a school needs. The systems are mainly for educational purposes. I would love to do bigger systems in the years to come."

It still takes someone with a passion to make it all happen. Someone, for example, like Charlie Garlow, a parent of two children at Pinecrest Elementary in Silver Spring, Maryland. When Garlow heard about the grants being offered by the Maryland Energy Administration, he started campaigning hard for Pinecrest to go solar. He has shepherded the program through every stage, from grant application through structural engineering, because he so passionately believes in solar energy.

Garlow and the Pinecrest PTA came up with all sorts of creative strategies to raise their share of the solar program: they sold compact fluorescent light bulbs and raffled off two handsewn quilts. Garlow successfully solicited private donations, large and small.

"I think of us as little Johnny Solarseeds," says Garlow, "spreading the good word about solar and watching other schools decide to do the same."

Contact: Jonathon Cross, Maryland Energy Administration, 410.260.7184.

Solar Schools a Symbol of Pride at Florida Utility

Twenty years ago, when he started working, Larry Wagner remembers that he felt like hiding the fact that he worked for Jacksonville's electric utility, it had such a bad reputation in the community. Now he is proud to say that he works for JEA — and especially proud, as project engineer of new technologies, to be part of the company's solar initiatives.

"We want to become a national model," says Wagner.

In the next year, JEA will install 10 four-kilowatt systems on area high schools; once the municipal utility's program is up and running, a dozen more school installations will follow. In the sunny Florida climate, each system will generate the equivalent of a household's electricity. With enthusiastic young people learning about solar and carrying the message home, Wagner says, "Schools are a great place to initiate that mind-set."

Fifteen years ago Larry Wagner helped Jacksonville's municipal utility set up a four-kilowatt PV system at the nature preserve on Pelotes Island. "We put it in as a photo opportunity and not much else," says Wagner. When lightning struck the inverter some years ago, the company didn't consider it a high priority to put the system back into operation. This past year, as part of its new dedication to solar school installations, JEA renovated the Pelotes Island installation. After 15 years, the solar panels still worked like new. Now school groups that go to the island to learn about marine ecology get a working lesson in solar energy too.

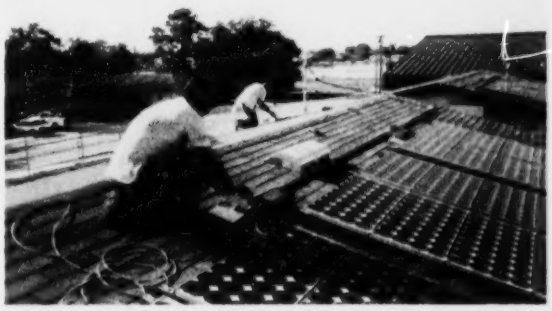
JEA is making the up-front investment, at $7 per watt, to buy the components and install the systems. Once the systems are operating, the Florida Solar Energy Center promises to rebate $2 per watt, up to a total of $100,000. Because of its overall interest in domestic-sized systems, FSEC will rebate costs for up to a maximum of four kilowatts per system.

Larry Wagner is proud of his company's commitment to clean energy. In a state where development often has to meet stringent environmental protection standards, solar energy makes his job a lot easier.

Contact: Larry Wagner at JEA, 904.665.6292.

Portable Classrooms Become Mini-Solar Power Plants

Portable classrooms — the temporary movable trailers that schools set up when student numbers exceed space — provide an ideal setting for photovoltaic energy generation. "They have very accessible rooftops. The physical site access is very attractive. We need to be near our own service wires, and we have wires coming right to these portable classrooms," says Jeff Curry, solar program manager for Florida's Lakeland Electric. What's more, says Curry, schools support the idea. "You ask them if they want PV and they say yes. How much easier can it get?"



A Lakeland portable classroom with PV.

With 17 in operation starting this fall, Lakeland's portable classroom PV systems are tiny portable power plants. No matter whether a class is meeting in the trailer or not, the 1,800-watt PV systems generate electricity that goes directly into the grid. "We're harvesting all the power that these units provide," says Curry.

From the utility's point of view, portable classrooms provide ideal mini-sites for generating electricity. From the school system's point of view, the trailer-top systems provide a learning experience. Lakeland Electric is developing a classroom-ready study program designed so that teachers can help students understand what's happening on the roof. It's a partnership among responsible organizations, says Curry.

Once teachers start using the classroom materials, says Curry, Lakeland Electric will consider the possibility of providing inside read-out meters. "We are, at a minimum, providing metering on every building, so that students can determine the output of their classroom system on a daily basis." Lakeland Electric has for many years worked in cooperation with the local schools, providing learning materials about electricity, says Curry, and the solar program adds a new and exciting twist.

Lakeland Electric participates in the UPVG's *TEAM-UP* grant program.

Contact: Jeff Curry, Lakeland Electric, 941.834.6853.

Detroit High School to Feature Solar as a Step to Sustainability

Because of what's up on the rooftop, students at Cass Technical High School in Detroit will be doing some interesting things down in the classroom. Installation of a rooftop multikilowatt solar array will give science and engineering students at Cass Technical a crack at hands-on experience with solar energy. They will be encouraged to put on demonstrations and presentations to reach out to other students and the community to increase awareness of renewable energy options.

The school's solar curriculum will build upon a fully accredited one that Detroit Edison already developed for grades four through eight. Once the high school curriculum is completed and accredited, other schools will be able to use it as well.

"The success of this project will have an important impact on future projects in other schools," said Cass Tech Principal George H. Cohen, Jr.

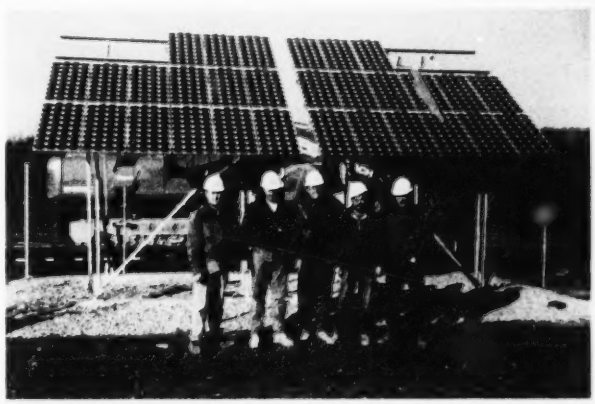
The photovoltaic array and solar curriculum will be the handiwork of a partnership among Detroit Edison, United Solar Systems Corp., and Cass Tech. United Solar is a joint venture of Energy Conversion Devices, Inc., of Troy, Michigan, and Canon, Inc., of Japan. Funding will come from the Detroit Edison Foundation and the State of Michigan (through the Michigan Manufacturing Technology Center).

The project grew out of preparations for a National Town Meeting in Detroit last May aimed at starting a national movement toward sustainable development, the achievement of prosperity without sacrificing the environment or quality of life. The Cass Tech project is intended as one of the "legacy projects" of the National Town Meeting built around sustainable energy practices that will serve as models for other schools and communities.

A Sense of Ownership Propels PV for Ohio Schools

Build one solar system, and others will come.

That's Glen Kizer's philosophy, and progress in the state of Ohio bears him out. Kizer heads the Foundation for Environmental Education in Columbus, Ohio, the inspiration behind a fast-growing network of solar schools throughout the state. Ten Ohio schools installed one- and two-kilowatt photovoltaic systems in 1998-1999, with another ten expected by the year 2000. All told, Kizer believes, if his foundation helps build the hundred school systems they are planning, Ohio will reap the benefit of at least a hundred more.



The Bluffsview installation in Ohio.

"We would rather see 15 buildings with one kilowatt than one building with 15," says Kizer. "Our purpose is not to replace the electricity of these buildings completely with solar. Our purpose is to get as many people as possible to see it, touch it, feel it."

It's a "domino theory" strategy, says Kizer, and it seems to be working. Ohio's first solar school, Bluffsview Elementary in

Worthington, dedicated its system in March 1999, thanks to assistance from American Electric Power, BP Solar, federal and state agencies, local corporations, and local individual donors. Worthington has already resolved to install a second system. When nearby Westerville saw what Worthington was doing at Bluffsview, they resolved to build PV systems on every one of their schools, too. "Five years ago school boards wouldn't have allowed us to talk to them," says Kizer. "Now they want to do all their buildings."

A Bluffview student speaks to the press about the solar project.

It's important, Kizer believes, to ensure that the community feels that they own the system. Corporate partners are great, but personal donations, especially from the parents of children attending the school, matter the most. "If you give a dollar and you see the system, you think, 'I helped build that.' It's an infectious thing."

Contact: Glen Kizer, Foundation for Environmental Education, 614.823.6243.

Showing that Solar Makes Sense in 'Sunny' Michigan

It all started with the innovative solar components being made in nearby Troy, Michigan, home of Energy Conversion Devices, Inc. ECD has played a key part in the development and manufacture of both thin-film amorphous solar cells and nickel-metal hydride batteries. Put the two together and you have a distinctive solar energy system, just like the one now supplying the energy needs and supplementing the curriculum in the eighth-grade physical science classroom at Lakeshore School in Grand Haven, Michigan.

"Our system has 360 watts of panels and 4.8 kilowatt-hours of stored energy in a bank of four batteries," says Melissa Jaeger, Lakeshore's eighth-grade science teacher. "What's unique about our system is the battery storage component. These batteries are those being used in GM's electric cars. We believe this is their first use in a solar application."

The overhead lights in Jaeger's classroom are tied in to those of other classrooms, so they can't be powered separately, but every other electrical device in the room is powered by the solar/battery system now in place. "We are trying to show the feasibility of a system like this, even in a place like Michigan, where the sun doesn't shine as much as we want it to," says Jaeger.

"We've had a lot of community support," says James Wolter, a professor of marketing at nearby Grand Valley State University who has helped Lakeshore develop its cutting-edge solar system. EDC and its companion companies — Canon for the solar cells, GM Ovonics for the batteries — donated the components. Ottawa Electric willingly reduced its charges when wiring costs exceeded the school's budget. A local fabricator contributed a stainless steel box, custom-designed to contain the bank of batteries. The Michigan Department of Energy awarded the project a $5,000 one-time demonstration grant.

"The intent is to publish information on this installation," says John Trieloff in Michigan's State Energy Office. "Hopefully, we will stimulate other self-motivated efforts."

Contact: John Trieloff, Michigan Energy Office, 517.334.7233.

Chicago's Brightfields Solar Initiative Benefits City Schools

The City of Chicago, Illinois, has turned a brownfield into a brightfield. Solar manufacturer Spire Corporation, headquartered in Bedford, Massachusetts, is opening an assembly plant on property abandoned when a debris recycler was charged with violating environmental ordinances. From that site, Spire will assemble photovoltaic arrays destined for public schools all over the city.

"Our Solar for Schools program represents a strong partnership between the State of Illinois, the City of Chicago, and the electric utility Commonwealth Edison," says Juli Pollitt, senior marketing manager with Chicago's regional office of the U.S. Department of Energy. Her office decided, when given the challenge of finding their way to participate in the nationwide Million Roofs initiative, that it would commit to installing solar systems on public schools at every level. The program works on three levels, says Pollitt: there's the installation of the system, curriculum tie-ins on renewable energy, and the larger message to the community.

First to be outfitted with PV and a curriculum to match will be Reilly School, which educates pre-K through eighth-grade students. Reilly principal Scott Rzechula expects the 10-kilowatt PV installation to reinvigorate the school's science and math programs. Monitors will be hung in the lunch room so students are constantly reminded of the energy being generated by the solar cells. Rzechula also plans a junior "Reilly Energy Company," with 15 to 25 fifth- through eighth-graders participating as a board of directors, which will sell electricity as a symbolic gesture back to the city's Board of Education.

The solar panels going up on the roof at Reilly Elementary will be installed thanks to the generosity of Chicago's Electrical Joint Apprenticeship Training Center, operated jointly by IBEW, the local electricians' union, and the National Electricians' Contracting Association. Training Center personnel didn't need any convincing about the value of solar: a 15-kilowatt PV system already powers their own building.

Contact: Juli Pollitt, U.S. Department of Energy, 312.886.8571.

Wisconsin School Adds PV Piece By Piece

Wisconsin's Waunakee High School is growing solar. With funds totaling more than $60,000 from state agencies, local utilities, and an area education foundation, weather and astronomy teacher Steve Bower is installing a photovoltaic system designed to get bigger and better over the coming years.

Bower is installing a rack capable of holding enough PV panels to produce 10 kilowatts of electricity. This year, he and students will install two kilowatts. Next year, they will install PV panels made by a second company. When they need additional inverter capacity, they will install another company's product. All the while, Bower and his students will be monitoring the meters, analyzing system output, and comparing the efficiencies in their multibrand solar array.

Other schools are using the loans to put in better-insulated windows, says Wolter. Waunakee chose to go solar instead.

"I'm using it as raw research," says Bower. In his weather classes, he will have students track how factors like wind speed and cloud cover influence energy output. In his astronomy classes, he will help students understand how NASA powers vehicles in space. Fellow teachers will turn the solar installation into real-world lessons as well. Accounting classes will compare the costs of electricity from various sources. Business and marketing classes will design fliers destined for utility customers' bills, explaining the ongoing project and encouraging individuals to contribute to its success.

"It's already got some great community support," says Niels Wolter of the Wisconsin Energy Initiative. The supporters include the Energy Center of Wisconsin, the Wisconsin Environmental Education Board,

the Wisconsin Energy Bureau, the Wisconsin Public Power Institute, the Waunakee Area Education Foundation, Waunakee Municipal (the local utility), and Southern Wisconsin Environmental Engineers. The project stands out among others receiving long-term loan funding through the Wisconsin Energy Initiative, which offers up to $10,000 in assistance for energy-efficient and renewable-energy improvements. Other schools are using the loans to put in better-insulated windows, says Wolter. Waunakee chose to go solar instead.

Contact: Niels Wolter, MSB Energy Associates, 608.831.1127, ext. 308.

SolarWise Powers Nine Wisconsin High Schools

Working at a pace of three schools a year since 1997, the Wisconsin Public Service Corporation has set a goal of installing solar electric systems on all 63 high schools within its northeast Wisconsin service territory. "We pioneered the Solar on Schools concept," says Chip Bircher, Project Manager for SolarWise for Schools. "We figure we're further up the learning curve than most others."

In September 1999, three more schools will be equipped with two-kilowatt PV systems, including Crandon, Pulaski, and Oshkosh-West, bringing the WPS total to nine; the area's next three schools, due for installation in the summer of 2000, have already been identified. Of the first six schools, three have 12-kW systems and three have 4-kW systems. Each year, many more schools apply for the program than can be accommodated. "We had to keep telling ourselves, 'There will be next year,'" says selection committee chairperson Jennie Lane of the Midwest Renewable Energy Association.

Lourdes High School team celebrates solar power at the WPS Solar Olympics.

WPS customers voluntarily contribute to the high school solar installations. Those contributions combine with U.S. Department of Energy grants from UPVG's *TEAM-UP* program, and grants from the Wisconsin Energy Bureau. "Contributions from customers keep going up," says Bircher. "This year we received about $62,000 from customers. We promote the program once a year, in a really low-profile campaign. Customers sign up, then their contribution is automatically placed on their bill. It's still optional, but our retention has been good, and we have a growing number of customers supporting the program."

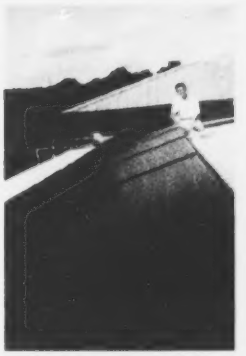
A SolarWise installation at De Pere High school.

Schools receive a three-week curriculum on renewable energy, which includes lessons on energy units and conversion, photosynthesis and the concept of biomass, the electromagnetic spectrum, and the component parts of a photovoltaic system.

The fun part of the WPS program is the statewide Solar Olympics, in which more than 100 kids from a dozen schools compete to test their solar savvy and demonstrate their designs for solar cookers,water heaters, cars, and sculptures. Teams compete in a rousing game of Solar Jeopardy, a great way to finish the celebration.

Contact: Chip Bircher, Wisconsin Public Service Corporation, 920.433.5518. E-mail: cbirche@wpsr.com

In Texas, the Power is the Icing on the Cake



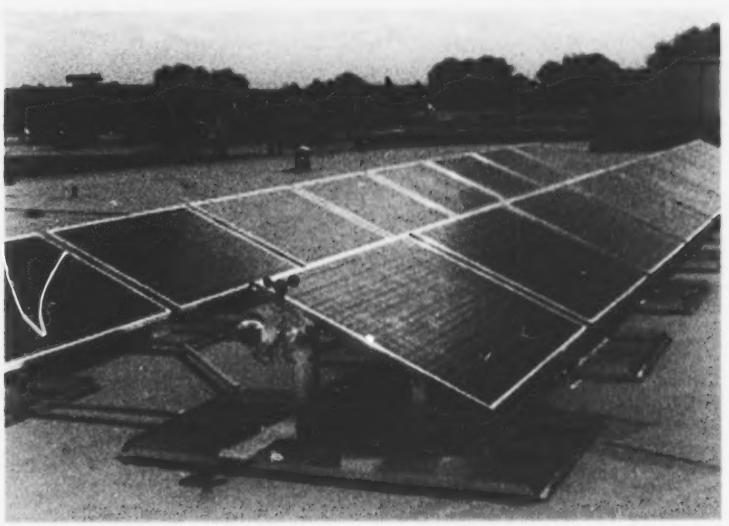
This fall, solar systems are going up onto school rooftops in Texas, Louisiana, and Arkansas at a rate of one a week, thanks to Central and South West Corporation's Watts on Schools program. CSW incorporates five utilities, including Central Power and Light in Texas, West Texas Utilities Company, and Southwestern Electric in Louisiana.

"Our corporate goal is primarily educational," says Terry Allison, Watts on Schools project manager in Dallas. "Anything you are doing for the schools, you are doing for the whole community. It's a focal point."

Working in partnership with Planergy, an Austin, Texas, engineering firm, by the end of the year CSW will have 19 photovoltaic systems up and running on schools and educational buildings. Planergy plays a critical role at many stages: designing and installing the PV systems, creating a "Watts in the Box" education kit for teachers, and — in an innovative business approach — serving as owner of the PV systems.

"We have agreed to own and operate the systems for ten years," says John Hoffner, director of advanced technologies at Planergy. "It's a long-term lease, not a contracting agreement. The utility pays us a monthly leasing fee. The schools get the PV systems as a benefit. We have a ten-year commitment to the project."

Each photovoltaic system generates four kilowatts of power. "That enough in this part of the country to run your house," says Terry Allison. Looking at it from the school's point of view, says Allison, a 4-kW PV system will operate the lights and computer in three or four classrooms, equivalent to between $400 and $800 worth of electricity each year.



The first Watts on Schools system at Childress (Texas) High School was energized July 3, 1999.

But that's not the most important value coming out of these systems, says Allison. "Most of our schools look at the electricity that the PV systems generate as the icing. The cake is the educational benefit."

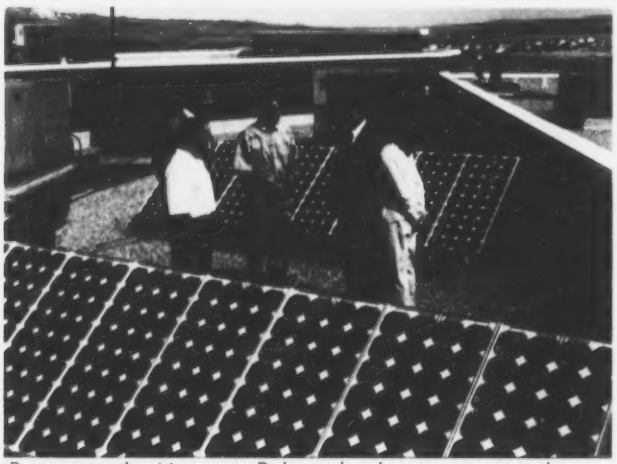
Through LED read-outs in school hallways, students will monitor how the photovoltaics are doing to the minute. Students will also be downloading real-time data onto the Watts on Schools Website, which will allow school-to-school comparisons of energy generation, use, and efficiency.

The 19 school systems being installed through the CSW-Planergy partnership received funding from the UPVG *TEAM-UP* program.

Contact: John Hoffner, Planergy, Inc., 512.327.6830. E-mail: jhoffner@flash.net

Solar at Colorado Springs School

Colorado Springs Utilities (CSU) partnered with government agencies, businesses, and a national trade association in April to install a one-kilowatt solar electric system at Mountain Ridge Middle School in Colorado Springs.



Partners in the Mountain Ridge school project inspect the system.

The demonstration project provides a hands-on educational opportunity for School District 20 students to learn about solar power and spread the word about renewable energy technology. It was also the first photovoltaic system installed in Colorado Springs that is tied directly to CSU's electric distribution system.

The photovoltaic installation was made possible through a cooperative partnership between CSU, the National Electric Contractors' Association, Berwick Electric, and the Governor's Office of Energy Conservation. Using a computerized monitoring station, students can see first hand the amount of energy being produced, on a real time basis, by the photovoltaic panels. The two 4-by-12 foot panels convert sunlight directly into electricity. The system generates about one kilowatt of electricity, enough energy for about two classrooms.

Contact: Jim McGrady at CSU, 719.668.3819.

PV Installed at 23 Colorado Public Schools

Since last November, photovoltaic systems were installed at 23 Colorado schools through a partnership between Public Service Company of Colorado (PSCo) and Altair Energy.

The PSCo/Altair systems produce two kilowatts of electricity and are tied to the utility grid system. Each will provide enough electricity to power one or two classrooms but "they are really meant as learning tools for the students," says Jennifer Harrison Lane, marketing director for Altair Energy.

The partnership plans to install up to 40 school solar electric systems throughout Colorado by the end of 2000. Eight more are scheduled to be in place by April 2000. "It's been very successful. The schools are thrilled to have this new technology to use in math and science classes," says Andy Sulkko, project manager of PSCo's tax-deductible Renewable Energy Trust, which allows customers to support renewable energy at schools and nonprofits. He says at least another 12 schools in the PSC service area are interested in joining the program.

In addition to the electric generation systems, Altair Energy is installing a computerized performance-monitoring station as part of the package so that "real-time" electricity generation and weather data is available to each classroom.

"Our company has trained the teachers about the system so they can then teach the kids," says Lane. "Also,we have provided extended service contracts that ensure proper maintenance."

Installations since November 1998 include: Rangeview High in Aurora; Crestview and Jamestown Elementary Schools in Boulder; Beaver Valley Elementary in Brush; Center Consolidated School in Center;

Denver School of the Arts, Horace Mann Middle School, Montbello High, and North High, all in Denver; Edith Teter Elementary in Fairplay; Ralston Elementary School in Golden; Dunstan and Everitt Middle Schools in Lakewood; Chatfield High, Dakota Ridge High, Highland Elementary, and Isaac Newton, Ken Caryl, and Powell Middle Schools, all in Littleton; Moffat School in Moffat; Sargent Junior/Senior High School in Monte Vista; Huron Middle School in Northglenn; and Horizon High in Thornton.

By providing the schools with educational program support and extended service contracts, Altair Energy will ensure that the PV systems will be a valuable educational resource for years to come, Lane said.

The cost of each system and monitoring equipment cost $30,000 to $40,000. The PV installations systems are being funded through the PSCo's Renewable Energy Trust Solar for Schools program, as well as by the Colorado Governor's Office of Energy Conservation and the UPVG/DOE *TEAM-UP* program.

Lane said the success of the Trust's program inspired three schools outside the PSCo service territory to raise money to launch their own solar power projects: Career Development Center in Longmont, Mt. Ridge High in Monument, and Yampa Mountain High School in Glenwood Springs.

Contact: Jennifer Harrison Lane, Altair Energy, 303.277.0025, ext.103. E-mail: jhlane@altairenergy.com.

Contact: Andy Sulkko, Public Service Co., 303.294.2554. E-mail: Asulkko@psco.com.

To contribute to the Renewable Energy Trust or to apply for a solar schools system, call 303.571.3434 (or 1.800.894.3368 outside Denver).

Students and teachers pose outside Powell Middle School, one of Colorado's Solar for Schools participants.

Contact: Martha Blackwell, Colorado Governor's Office of Energy Conservation, 303.620.4292, ext.213. E-mail: marthab@sni.net.

Colorado Career Center Uses Sun to Power Lab

The Career Development Center in Longmont, Colorado, raised $25,000 needed to install its PV system from a variety of sources, including the state Office of Energy Conservation ($9,000), the Platte River Power Authority ($5,000), the City of Longmont ($3,000), the local school district ($5,600), the Utility PhotoVoltaic Group ($1,350) and a $1,750 federal rebate.

The Longmont one-kilowatt, line-tied helps power the school's technology lab.

"This will benefit those students who have an interest in learning how the technology works," says Ralph Bozella, energy educator for St. Vrain Valley School District. "Hopefully, the students who become interested can help make solar more usable and more efficient on a residential basis."

Contact: Ralph Bozella, St. Vrain School District, 303.776.6200. E-mail: Bozella_Ralph@St.vrain.k12.co.us

Alternative School Installing Array

This fall, a small alternative high school in Glenwood Springs, Colorado, is expected to install a 960-watt, grid-tied system on its main school building. The PV array at Yampa Mountain High received financial support for the project from the City of Glenwood Springs, the Commission of Resource Efficiency (CORE), the state Office of Energy Conservation, and the school district.

Contact: Robin Millyard, Glenwood Springs School District, Director of Public Works, 970.945.2575.

Phoenix Schools, Utility Join for Solar Power

In 1999, Deer Valley Unified School District in Phoenix, Arizona, installed nine kilowatts of PV rooftop systems, both at Constitution Elementary School. One five-kilowatt system is owned by the school district. The other, a four-kilowatt system, was installed on school premises as part of the Arizona Public Service Company's Solar Partners green pricing program. The facility is owned by the utility, hosted by the school, and subsidized by the utility's customers.

The total unsubsidized cost for the installation is about $8 per watt, said Casssius McChesney, APS solar program manager. He said the costs were shared about one-third each by the Utility PhotoVoltaic Group (*TEAM-UP*), APS, and the utility's customers.

McChesney said the school district is interested not only in energy conservation but also renewable energy. "From an educational standpoint, they wanted to teach their children not only about responsible energy use but also about renewables. They wanted to demonstrate their commitment by installing photovoltaic energy at their school."

Contact: Cassius McChesney, 602.250.3124. E-mail: 207788@apsc.com.

California Schools Using Daylighting and Solar Thermal

The Western Christian Elementary School in Upland, California, in September 1998 installed solar-powered electric generation, plus a control system for natural ventilation (space conditioning), and daylighting.

The Newport Mesa School District in Orange County is constructing a new school with daylighting and solar thermal systems.

Three prototype 'relocatable' classrooms designed by Southern California Edison and featuring daylighting, natural space conditioning, the use of sustainable materials, and efficient lighting were delivered to Los Angeles-area schools this fall.

Contact: Gregg Ander, Chief Architect, Southern California Edison, 626.633.7160.

Innovative PV and Educational Systems in California

An educational meter adds value to two sizeable school PV installations completed in 1999 in California.

Near San Diego, the brand-new Teofilo Mendoza Elementary School opened in Imperial Beach this fall with 12 kilowatts of Uni-Solar metal roofing PV panels built into a lunch shelter. In Palo Alto, the Henry M. Gunn High School has a five-kilowatt system powering the 50 personal computers in the science building's computer laboratory.

Both systems were installed by Solar Utility Company and feature the company's Envirometer, which measures the power being produced and the tons of carbon dioxide emissions offset by the solar power systems.

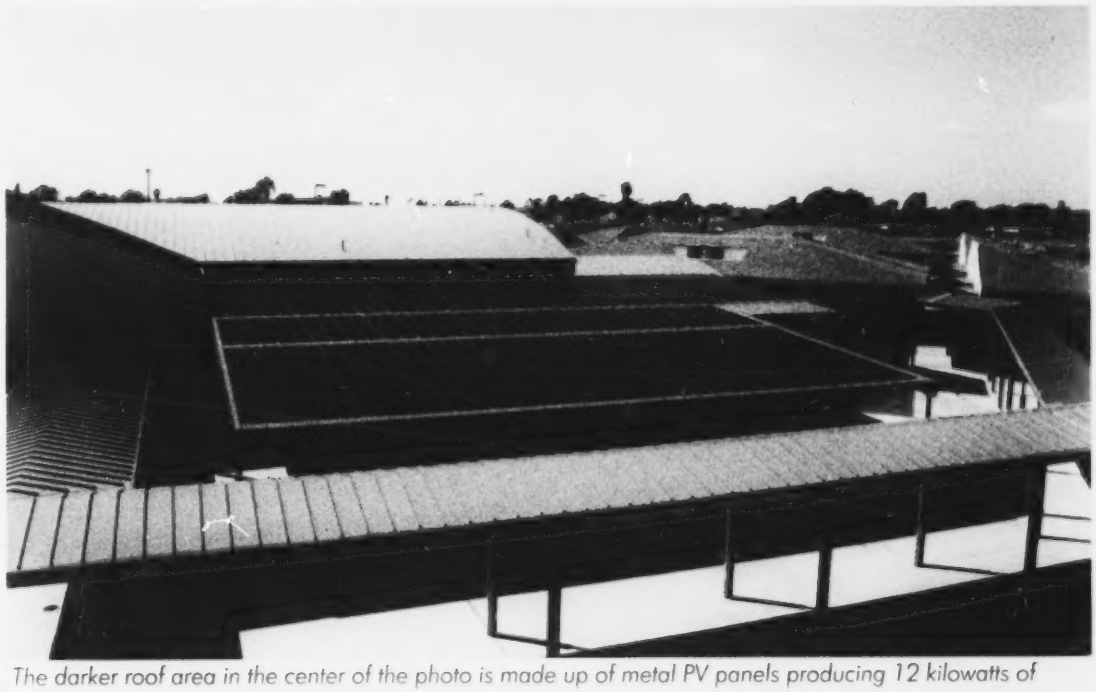
Solar Utility's Envirometer.

The Henry Gunn solar panels.

The Mendoza School received California Energy Commission funding, while the Gunn School utilized grants from the school district, Edison International, and a rebate offered by the the City of Palo Alto Utility Department.

Speaking of both schools' motivation for adding the solar units, Steve McKenery, Solar Utility CEO, concludes, "I think they thought it was good for the environment and good hands-on experience in the classroom."

Contact: Steve McKenery, 310.410.3934. Website: www.solarutility.com



The darker roof area in the center of the photo is made up of metal PV panels producing 12 kilowatts of electricity at the Teofilo Mendoza school, enough to power several classrooms.

Sacramento Goes into Solar Schools in a Big Way

The Sacramento Municipal Utility District (SMUD), arguably the world's leading solar power utility, recently added a first to its long list of solar installations: a solar-powered school.

In keeping with the scale of SMUD's solar endeavors, the school system is a whopper. While the typical PV system being installed on school rooftops averages between one and four kilowatts in output (enough to power a handful of classrooms), SMUD's installation on the Kit Carson Elementary School in Sacramento produces 27.7 kilowatts of electricity.

It also employs a cutting-edge PV product: a roofing shingle (or "slate") made by Atlantis Energy, says Craig Hoellwarth, principal at Quest Consulting and a project designer.

The facility was paid for under SMUD's Pioneer I program, which promotes solar installations on public buildings. SMUD's Pioneer program covers the cost of the project, in return for the electricity generated by the system. The school district has the option, at any point in the future, to purchase the PV system.

"It's a very good way for a school to get into using solar energy because it takes away that large first cost," says Hoellwarth. "When they see the system in place, particularly the solar slates, they are elated."

He notes that the school district liked the idea because of its educational value and for another very pragmatic reason. "They needed to replace the old asphalt shingle roof anyway, so, with the roof-integrated PV, they got one large face of the roof taken care of."

Contact: Craig Hoellwarth, 916.683.8378. E-mail: Westdakota@aol.com.

This roof of Sacramento's Kit Carson School is covered with solar electric roof slates.

Getting Busy School Officials to Think about Solar

Craig Hoellwarth, an architectural and solar design specialist at Quest Consulting of Elk Grove, California, feels that, at this point, school officials will not likely buy into a solar add-on without some special attention.

"In this and many areas across the country, there is such pressure to build new schools and keep the costs under budget that it isn't enough to present generic information," says Hoellwarth, who helped turn a south-facing roof of the Kit Carson school in Sacramento into a mini-electric plant with the addition of solar roofing slates. "We have a compelling case: you can have a roof that will actually pay you money. No other roof will do that. It will last longer than a conventional roof, and you have a permanent science project. That's great, but we need to do an analysis of a specific school and take that to the school officials, to show the return that's possible in the project they have to complete."

Hoellwarth says this case-by-case promotion will be critical until the advantages of solar are so obvious and widely appreciated that it becomes another standard option.

The value of solar technologies is enhanced when used as a complement to energy-efficient designs and materials and other renewable energy technologies. Hoellwarth believes that photovoltaics and geothermal heat pumps are a natural combination for schools.

"The geothermal systems use the earth's temperature to provide warm or cool air, while the PV on the roof provides the power to circulate it through the school," he says.

Mendocino School Goes for Complete Solar Package

Albion Elementary School near Mendocino, California made use of special funds to install the "full array" of solar technologies — PV, thermal, and daylighting.

The school receives electricity from a 5.5-kilowatt photovoltaic system, hot water from a 22-panel thermal system, and has turned off the school's flourescent lights in favor of daylighting. Replacing the "awful" fluorescent lighting had perhaps the biggest effect on the students, said Steve Heckeroth, Homestead Enterprise's solar designer. "Now, they are learning in daylight conditions."

The system was paid for through the Petroleum Violation Escrow Account, which includes fines levied against oil companies for oil spills and other violations. The account can only be used to clean up environmental disasters and to promote renewable energy. The use of the fund for the school's solar array was pushed by State Assemblywoman Virginia Strom-Martin.

Contact: Steve Heckeroth, 707.937.0338.

Edison Technology Provides Solar Power for Schools

Edison Technology Solutions provided three southern California schools with solar power in 1998. Two were mounted on lunch shelters at Glen Mead Elementary in Chino Hills (10-kilowatts) and Montera Elementary in South Gate (4.8-kilowatts).

Also in Chino Hills, ETS placed an eight-kilowatt system on the roof of the Boy's Republic School. UPVG *TEAM-UP* funds supported these projects.

Contact: Steve Taylor, 626.815.0530. E-mail: staylor@edisontec.com.

Solar Schools Grow by Threes in Washington State

Each year about three schools in Washington state chose to add solar installations, says Mike Nelson, PV projects manager for Washington State University's Cooperative Extension program. By the end of 1999, new PV installations will include facilities at Clark County Public School District, Kent School District, and Stuart Island in the San Juan Islands.

The 600-watt Clark County project offers the feature of providing uninterruptible power supply for the computer room. "If there is a lightning or wind storm in western Washington, then the kids don't have their computers crash and lose their homework," Nelson says.

The one-kilowatt Kent School system is part of new construction at the school. It is complemented by a new wind turbine for additional renewable power. The Stuart Island school is not served by any electric utility and so has added an almost one-kilowatt PV installation.

Contact: Mike Nelson, 360.956.2148. E-mail: nelsonmk@energy.wsu.edu.

Hawaii Utilities Expand Sun Power for Schools

So far, 12 schools in the Hawaiian islands have installed solar systems as part of the Sun Power for Schools program conducted by three Hawaiian electric utilities. A thirteenth school, Lahainaluna High School on Maui, plans to install a solar security lighting system under the program by the end of 1999.

Students at Waipahu High watch HECO crew setting solar panels in place.

Hawaiian Electric Company (HECO), which serves Oahu, completed four projects last year at: Waipahu, McKinley, Waianae, and Campbell Schools. Three solar systems installed this year are: Mililani, Wailua and Castle. The most recent project, Castle High School's two-kilowatt PV system, was installed August 18. Sun Power for Schools is a utility-community partnership program under which utility customers and community members can make donations that are used to buy and install solar electric systems at public high schools.

Under the SPS program, the utilities have worked in concert with the state Department of Education to develop supporting curricula to teach high school students about renewable energy. Sun Power for Schools receives funding assistance from the UPVG's *TEAM-UP* program.

Steve Burns (right) of HELCO discusses solar power with a teacher at Kealekehe High School.

Hawaii Electric Light Company (HELCO), which serves the island of Hawaii, is also participating in Sun Power for Schools. By the end of 1998, HELCO completed a new solar system at Hilo High School and another at Kealekehe High School. The 1.14-kilowatt system at Hilo is designed to save about $300 per year on the school's electric bill. Besides providing power to the school, the solar system is equipped with a data logging device that collects information on solar insulation, ambient temperature, system power output, and wind speed.

In the summer of 1999, HELCO offered Project BITS (Business Internship for Teachers). The program allowed teachers to work in partnership with the utility to develop an energy education supplement relating to the Big Island's renewable energy resources for the elementary school level.

The program defined renewable resources on the island with pictorial models that demonstrate how each produces electricity. Lessons were developed for three different grade levels, and the teachers were provided a directory of future contacts, arrangements for field trips, and a list of other resources such as videos and Internet sites.

Maui Electric Company's solar installation at Molokai High School in May 1999 joined an existing facility at Baldwin High School. The planned installation at Lahainaluna High School will bring Maui's total of solar schools to three.

Contact: Eileen O'Hara-Weir, 808.969.0144 or Lynne Unemori 808.543.7972. E-mail: Lunemori@hei.com.

A crew from Hawaiian Electric installs a PV system at Campbell High School.

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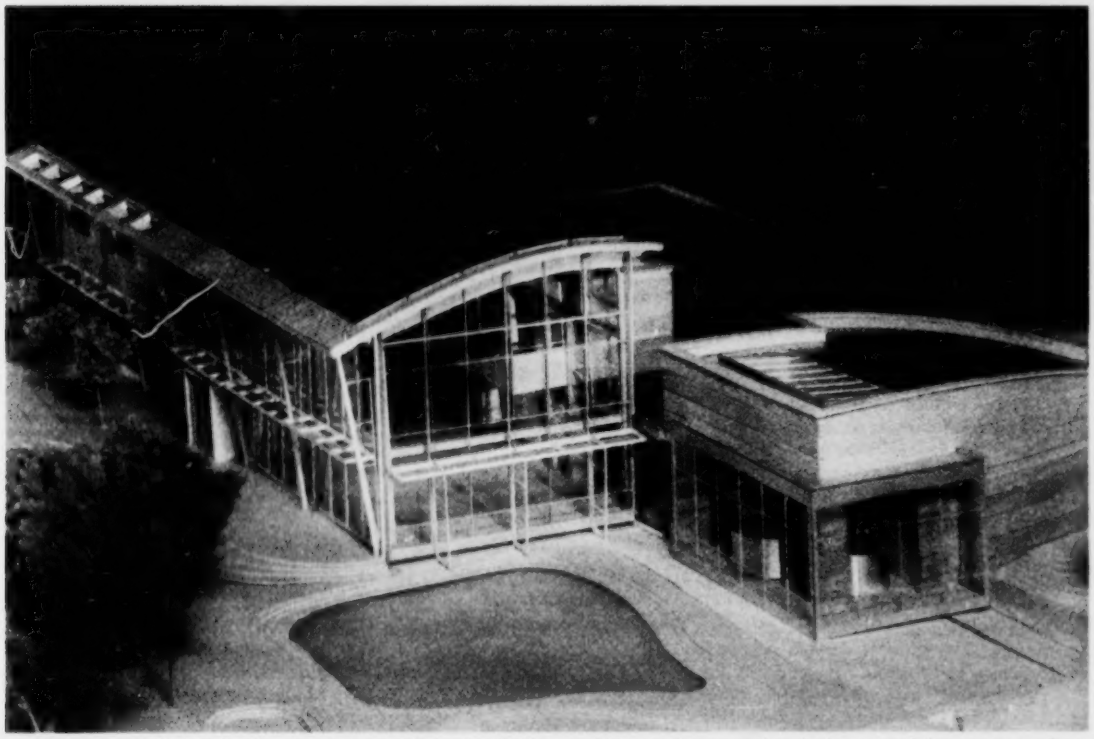
Where It's Working: Colleges and Universities

A School Building Designed to Produce More Energy than It Consumes

A building that on completion this fall at Ohio's Oberlin College will be one of the most ecologically advanced in the nation is expected, in time, to use rooftop solar cells to export electrical power.

The much-anticipated Adam Joseph Lewis Environmental Studies Center is expected to use only 21 percent of the energy of a typical new classroom building in northern Ohio. Many environmental features will contribute to the light energy load, including 3,700 square feet of photovoltaic cells on the center's main curved roof that will generate electricity for the building. A regenerative fuel cell, integrated with the PV panels, will provide energy storage. Passive solar, direct solar gain, and daylighting for all interior spaces will also be employed.

The solar panels clip onto the roof so they can be replaced with upgrades. Anticipated advances in PV efficiency, project designers believe, will allow the building to become a net supplier of energy within five years.



Architect's model of the Lewis Center at Oberlin College. PV panels cover the dark area of the main roof.

The solar installation is complemented by a long list of other energy-saving and "green" features apart from the solar tactics. The mechanical system includes closed-loop geothermal wells and earth energy heat pumps to heat, cool, and ventilate. It also employs thermal mass and storage and radiant coils under the concrete slab to heat an atrium. The heat pumps are individually controlled, permitting simultaneous heating and cooling within the complex as well as lower operating costs.

There is a natural wastewater treatment system that mimics the purification processes of ponds and marshes, recycling water for nonpotable "gray water" use in toilets through the building. The complex makes use of recycled materials and the lumber used for construction and furnishings will come from forests certified as sustainable.

The center generally reflects the belief of David Orr, chair of Oberlin's environmental studies program, that school design, in subtle but profound ways, affects what students learn.

Every school, college, and university has "a hidden curriculum consisting of its buildings, grounds, and operations," wrote Orr in *Yes! A Journal of Positive Futures*. "The extravagant use of energy in buildings, for example, teaches students that energy is cheap and can be wasted. The use of materials that are toxic to manufacture, install, or discard teaches carelessness about the use of Creation and a kind of mindlessness about where things come from and at what cost. Windowless rooms, or those with windows that do not open, teach that nature is to kept at arm's length."

Contact: Oberlin College, 440.775.8474. E-mail: news.services@oberlin.edu.

Putting Tomorrow's Energy Savings into Solar Power Today

With hopes to demonstrate to the whole state of Texas — and beyond — what solar energy can do for high-tech research and education buildings, the University of Texas' Houston Health Science Center has installed a 20-kilowatt photovoltaic system on the roof of its parking garage, providing electricity to light the garage and sending excess back into the Houston Light and Power grid.

In designing this system, the Health Science Center worked with the State of Texas, which recently implemented a system that allows organizations to bankroll their present energy savings. Instead of simply absorbing energy savings back into the state budget, Texas allows an organization to spend those savings on further renewable energy investments.

The rooftop solar installation at the Health Science Center in Houston.

"It's a great step," says John Hoffner, director of advanced technologies with Planergy, the Austin-based energy service company that designed and installed the Houston PV system. Already, through this installation and other measures, the center has reduced its total energy consumption by 30 percent, resulting in an annual saving of $1.5 million. The lessons to be learned by monitoring the parking garage

rooftop system will be used in the design of the Health Science Center's new $70 million Nursing and Biomedical Science Building, due to be built over the next three years.

Hoffner admires the dedication of Houston Health Science Center personnel like Brian Yoeman, assistant vice president of support services, who has advocated energy innovation on his many buildings. "They're incredibly conscious about energy conservation. They take a holistic view. They are fighting huge bureaucratic issues, but they want to be leaders."

The installation was supported in part with funds from the UPVG's *TEAM-UP* program.

Contact: John Hoffner, Planergy, Inc., 512.327.6830.

Solar Meets the Merchant Marine Challenge

Captain Douglas Brown encourages his students to think big. An engineering instructor at the U.S. Merchant Marine Academy, four years ago he set them to the task of making the cleanest fuel they could come up with. Their solution: use electricity generated by photovoltaics to power the electrolysis of water, resulting in hydrogen, a nonpolluting fuel.

Twenty-four 60-watt solar panels now gather sunlight atop the roof of the academy's engineering building. Alongside them spins a wind generator, pumping more power into the 48-volt system, wired into a hydrogen generator (or electrolysis machine) in a laboratory room below. Brown acquired a Russian fuel cell capable of running on a hydrogen-air fuel mix without cooling. By the end of this year, he and students will be storing hydrogen in the fuel cell. Next year, Capt. Brown predicts that students will power a vehicle with the cell.

"My students developed a proposal to take the Rocky Mountain Arsenal in the city of Denver and turn it into 400 acres of solar panels," says Brown.

The project has turned academy students into environmental visionaries. "My students developed a proposal to take the Rocky Mountain Arsenal in the city of Denver and turn it into 400 acres of solar panels," says Brown. "We would use the panels to manufacture hydrogen from water, then power Denver's mass transit system. We did the engineering proposals and sent a letter to Vice President Gore. We got a form letter back, but it did say that this was a great idea."

While solar energy isn't usually considered part of a merchant marine curriculum, Capt. Brown says that his students are excited by the classroom challenge, and they are finding jobs. "One out of five of the kids who goes through this course I've been developing gets a job in the alternative energy sector, working on fuel cells, wind generators, photovoltaic panels."

Contact: Captain Douglas Brown, U.S. Merchant Marine Academy, 516.773.5743.

Where It's Working: International

Britain's Solar 'Scolars'

Close to 20 British primary and secondary schools and technical colleges have already gone solar, and by next spring a total of 100 are slated to be drawing electrical power from photovoltaic panels. Beside the hardware, the schools gain access to the Internet and real-time experience of PV power through a specially tailored teaching program.

More than 500 academic institutions expressed interest in the program, called Foresight Scolar. It is part of a wider government initiative to stimulate interest in renewable energy. Prime Minister Tony Blair's government has set itself a target of deriving 10 percent of electricity in the United Kingdom from renewable resources by 2010. The Foresight Committee selected photovoltaics as the highest priority energy source it wished to promote. The Scolar program was one of 24 winners from an initial 530 "clean energy" submissions. The Scolar schools will act as demonstration sites for PV technology to the next generation.

The program is a collaboration between the government, industry, and universities, and is managed by the Intersolar Group, described as the oldest photovoltaic company in Europe. The government and industry are paying the lion's share of the cost, while participating schools contribute about one-third of the cost of each PV system — roughly $6,500.

Schools and colleges have a range of solar electric designs to consider, including a canopy, window louver, or wall cladding. Systems range from 500 watts to one kilowatt in power output.

The primary purpose of these small installations, says Frances Crick, project engineer from IT Power, a key participant, "is not to provide electricity to the school, not to cut school fuel bills, but to show how a PV system can be integrated into the building and how they perform."

A computer, complete with teaching material, is delivered to each school. The computer allows students to monitor the level of sunlight, temperature, and power delivered. All schools have access to the Internet and a Website, on which each has a separate page to which they send data. The industry-university consortium compiles the overall output. The site will permit people to "see what's happening at different systems," says Crick. Some of the schools are interested in contacting U.S. schools using PV power, she adds.

For more information: www.scolar.org.uk.

Switzerland: Number One in Solar

In developing a national solar program that is the world's leader in per capita installed capacity, the government of Switzerland caught the attention of the public by first focusing on schools.

Between 1993 and 1996 a total of 155 primary, secondary, and high schools installed a combined PV capacity of 803 kilowatts, thanks to a 30-percent subsidy provided by the Swiss government. In a country of only seven million people, this was the equivalent of 5,700 American schools adopting solar, notes Thomas Nordmann, a leading Swiss solar advocate.

In 1997, the government replaced the school program with a much broader buildings program (both on- or off-grid). By the end of 1998, about 1.7 megwatts of PV capacity had been installed through the

national program, on more than 300 buildings, including 32 industrial and agricultural facilities and 127 homes.

The Swiss also have installed grid-connected PV in vocational colleges to educate students studying in the electrical field about renewable energy. Students do the installation themselves. In the past six years, systems have been put into service at 24 vocational colleges with total installed power of 191 kilowatts peak.

Contact: Thomas Nordmann by E-mail: nordmann@tnc.ch.

Aachen Schools Host 'Model' Solar Program

Ten schools in the German city of Aachen (pop. 250,000) host PV systems as part of a public system to increase local use of solar power. In all, homeowners, small business people, and other citizens have installed a total of 210 solar rooftop arrays in the past four years on homes, schools, churches, a university, small businesses, a stadium, and elsewhere in Aachen. These systems generate a total of about 900 kilowatts, of which 190 kW is on the schools.

The private installations are heavily subsidized by national and city hardware funding. The owners of the photovoltaic systems are guaranteed a purchase price of 60 cents per kilowatt-hour for 20 years, a three to four percent return on the subsidized investment, according to Klaus Menirs, an engineer with the Aachen department of environmental administration. Despite the low return, people are willing to do it for environmental and other reasons, Menirs says.

The power generated goes into the Aachen electrical grid, where a portion is voluntarily purchased at a premium price. Schools have helped promote the green pricing purchases. So far, about 25 other German cities, large and small, have launched programs based on the Aachen model.

The Sun is On Line at Hundreds of Schools In Northern Germany

Across northern Germany, photovoltaic systems on schools that students monitor and operate themselves are becoming commonplace. More than 330 high schools (called "gymnasia") and technical schools have PV installations through the SONNEonline program of Preussen Elektra and 31 regional utilities. PV is due to be installed at more 120 more schools by the end of the year. A personal computer and Internet access are part of the solar energy package.

The one-kilowatt systems are distributed as standard construction kits and built by students under the supervision of a technician. The systems can be installed on the ground, on a flat or sloped roof, or into the building façade. The power generated (approximately two kilowatt-hours per day or 700 to 800 kilowatt-hours per year) is tied into the school's electrical systems.

Students use the Internet to exchange data and to learn about other developments in PV technology. The Fraunhofer Institute for Solar Energy (ISE) in Freiburg manages the scientific aspects of the project. The Fraunhofer ISE records and analyzes data from the SONNEonline systems, which is then placed on the Internet, allowing students to compare other schools' data with their own.

In addition to a software package for recording and evaluating PV data, each school receives two

extensive kits with which students can perform a variety of experiments on the conversion of solar radiation to electricity. Some students construct visual displays of PV data in school lobbies or elsewhere. The SONNEonline homepage offers discussion forums for students and teachers as well as the public.

An educational advisory board composed of teachers and administrators works with Preussen Elektra staff to guide the project.

For information: www.sonneonline.de.

Bavarian Schools Install Solar to Meet Public Goals to Increase Renewable Energy

Students and teachers at some 500 Bavarian public schools in Germany are running photovoltaic systems which they designed and installed on their own under the sponsorship of a group of utilities led by Bayernwerk. The utilities provided each participating primary, middle, or high school a kit for do-it-yourself installation on the ground, wall, or roof. The utilities bore most of the total cost, with each school paying about $2,000.

Bayernwerk planned the "Sun for Schools" venture with the Bavarian Ministry of Culture under the utility's program to build three megawatts of PV capacity in Bavaria as part of the Bavarian state government's drive to triple the use of renewable energy from five to 15 percent. In the schools, Bayernwerk's goals included inspiring the next generation to become involved in renewable energy and to improve the market for PV.

Initially, the utility's goal was PV installations on 100 schools. But announcement of the program spurred such a flood of applications that Bayernwerk tripled the number of schools, and in a third stage added another 200. All the systems were installed between 1994 and 1997.

Each school installed a 1.1-kilowatt system. Each system produces, on average, 88 kilowatt-hours a year. That's just one percent of the energy a school needs, says project engineer Ralf Knapp of Bayernwerk. Sun for Schools is intended as a demonstration program, he explains, "to give students an idea of what a solar system can do and can't do."

The project was designed to be incorporated into the classroom. Schools received educational materials about PV and renewable forms of energy, and utility company staff are available onsite for advice and assistance. The schools submit annual logs of measurements made on the system, which are evaluated by the Bayernwerk group.

Bayernwerk plans to evaluate the data submitted over a 10-year period to learn about the durability and maintenance needs of PV components.

The German government has encouraged other states to adopt the Bavarian plan.

Solar Education

Solar a Tonic for Environmental Stress

There are a lot of reasons why Greenpoint Williamsburg, a neighborhood in the north end of Brooklyn, was designated an "environmental justice community" five years ago: a wastewater treatment plant, 23 waste transfer stations (including one for low-level radioactive waste), a multimillion-gallon underground oil spill, exceedingly high lead-poisoning rates, the Brooklyn-Queens Expressway — all of these were factors that made environmental education in Greenpoint Williamsburg an urgent need.

Lara J. Warren, project manager for the Training Student Organizers Program of the Council on the Environment in New York City, teaches environmental improvement classes throughout the Greenpoint Williamsburg neighborhood. "The kids organize their own action projects," says Warren. "They love it. Energy awareness is a successful topic to work with with kids."

Solar school students at Newton Middle School in Littleton, Colorado learn about photovoltaics.

At St. Anthony's in Greenpoint, kids created a homemade solar collector by painting coffee cans black and attached them end to end, then ran the entire tube into a plexiglas box, heating the air inside to almost 80 degrees. At I.S. (Intermediate School) 318, students performed an energy audit, calculating the electricity used by all the school lights and establishing a conservation drive in which every classroom switched off the row of lights closest to a window. At St. Stanislaus Kostka, kids organized an Energy Fair where, among other displays, they got to see demonstrations of Junior Solar Sprint cars. Warren took students to visit the rooftop of the Gun Hill bus depot in the Bronx, to see a large, 300-kilowatt, photovoltaic system installed by the New York Power Authority.

"The kids were trying really hard to get some solar panels on their school," says Warren. Funding didn't come through, but energy consciousness did. It's a step in the right direction.

Contact: Lara J. Warren, Council on the Environment of New York City, 212.788.7193.

Solar Now Places Summer Interns

To help develop a strong solar future, Solar Now, a nonprofit corporation in Beverly, Massachusetts, sponsors education programs for kindergarteners up to graduate students. For the older age group, they arrange summer internships, placing dedicated college and graduate students in positions where they will learn hands-on about solar energy.

"We identify college students from around the world interested in solar energy," says project director Carmel Valianti-Smith. "Each summer we place three to eight students, sometimes as young as juniors in college and sometimes as far advanced as postdoctoral fellows. We place them in paid positions, working in the private or public sector. We cover their costs to get to the job, and in the end, they have a product to show for their efforts."

With funding from Massachusetts Electric, Solar Now placed three interns during the summer of 1999. Steven St. Laurent, a mechanical engineering student at the University of Massachusetts in Amherst, worked at Halibut Point State Park, developing renewable energy demonstration systems there. Zeke Yewdall, an electrical engineering student at Gonzaga University, worked at the Florida Solar Energy Center in Cocoa, Florida, helping develop software that gauges energy use and efficiency measures in homes. Nicole Robillard, a graduate student in urban and environmental policy at Tufts University, worked in the Climate Initiative Program at the Fletcher School of Law and Diplomacy, reviewing proposed renewable energy demonstration projects for three colleges.

Every student, and every supervisor, reported back to Solar Now that the summer had been a positive experience all around.

"I could not have imagined a better internship for the summer," says Steven St. Laurent.

"Zeke really helped with our work this summer," says Dan Parker at the Florida Solar Energy Center.

"I believe Nicole felt she was making a difference," says Professor William Moomaw at the Fletcher School of Law and Diplomacy. "We have offered her as much work as she can handle next year."

Contact: Carmel Valianti-Smith, Solar Now, 978. 927.9786.

On the Starting Line: Solar Car Races Expand Across the Country

Solar car competitions for middle-schoolers are thriving in locations around the country. Some are sponsored by utilities, such as TXU's competition in Texas and Oklahoma, and Wisconsin Public Service's Solar Olympics. Others are backed by state and regional energy organizations and private businesses. Here are a few examples of 1999 activities:

- A fun, hands-on learning program for solar energy describes the Junior Solar Sprint, an educational program/race for 6th, 7th, and 8th grade students coordinated by the Northeast Sustainable Energy Association (NESEA). The students gain theoretical and engineering skills which culminate in building a solar-powered model vehicle designed to compete in a 20-meter, wire-guided race.

Working in teams, students are provided with kits that include a motor and a photovoltaic panel. The chassis, wheels, and transmission are made from materials supplied by the students.

For further information, contact NESEA, phone: 413.774.6051, E-mail: nesea@nesea.org, Website: www.nesea.org.

• In Iowa, the Iowa Energy Center brought together students from 33 schools entering 143 cars in the state competition on May 22. For more information, go to the Iowa Energy Center Website (www.energy.iastate.edu/eduinfo/rayses) or E-mail Hector Ibarra (hector-ibarra@uiowa.edu).

Peter Perkowski, first place winner of the 1999 Maine Solar Blast (the regional Junior Solar Sprint in the northeastern U.S.), shows his winning car, Spree. Perkowski won first place in the Innovation and Craftsmanship categories and third in Technical Merit, clinching his Grand Prize.

• In Indiana, the 1999 Junior Solar Sprint was held on May 15 in Columbus, attracting 117 students from five middle schools racing 48 cars. Close to 100 parents and teachers attended. Prizes were given in Design and Performance, with a Design Process Award to recognize the team that went about designing their car in the best and most innovative way. "The design judges talked with the kids, getting a feel for what the kids tried, what they had thought of, and looked at any sketches and calculations the kids had made," says Glen Haegele, one of the event organizers. Contact: Haegele by E-mail, GT.Haegele@mailhub1.ctc.cummins.com.

Arizona's Solar Energy Institute

A dozen high school students from three states participated in the Third Annual Arizona Solar Energy Institute the week of July 17-24. As part of the course of studies, students undertook three hands-on experiments that allowed them to put their newly acquired solar knowledge to the test.

Students competed in two contests, one to build and race solar-powered bicycles, the second, a solar cook-off. The third exercise — a solar hot air balloon project — gave the group an opportunity to work together toward an exciting end result.

The solar hot air balloon project was created by Santa Fe resident Scott Morris in 1978. Students were given a solar chimney and balloon, with the instructions to use their knowledge of passive solar energy to inflate the balloon to the point where it would lift a three-liter bottle of water off the ground. The groups devised their own strategies of where and when to deploy the chimney, and how to funnel the hot air into the balloon. The result: the students launched the balloon in a record time of 57 minutes and 57 seconds into the project.

Contact: Jim Arwood, Arizona Energy Office, 602. 280.1409.

Los Angeles Contest for Green Power Draws Large Turnout

More than 425 students participated this year in a major citywide contest for renewables sponsored by the Los Angeles, California, Department of Water and Power. About $50,000 in savings bonds and cash were awarded in a May 24 ceremony for the first "Green Power for Green LA" initiative, which included students attending public, private, and parochial schools in the department's service area. The second contest is scheduled to begin in October.

The first contest extended from January to May and included a K-8 grade poster contest and a multimedia competition for high school students that included logos, songs, and videos. The winning song, written by a North Hollywood High School eleventh grader, was played more than 150 times on local radio stations.

In February, the sponsor held three workshops for teachers in which they studied three Green Power curriculum plans. The first group used a 16-page lesson book entitled *Electricity for Solar, Wind, and Sunlight*. Another studied art design, while a third group used a curriculum specifically prepared on Green Power and developed under contract by LADPW.

Awards included $10,000 in savings bonds for students and cash awards totaling approximately $20,000 each to teachers and schools. The contest produced 35 winning entries. Five of the winning posters were displayed in a May 12 *Los Angeles Times* feature article and later in an August exhibit at Dodger Stadium.

In the upcoming contest, winning artwork entries will be incorporated in a variety of printed pieces, including poster calendars from elementary school participants and pocket calendars from high school participants. Greeting cards and note cards may also be generated from the winning entries.

Other additions in next year's contest include a website seeking student enhancement and the promotion of solar power in community projects as part of the Green Power contest.

Contact: Walter Zeisl, LADWP, 213.367.1342. E-mail: wzeisl@ladwp.com.

SolarQuest

SolarQuest, a service learning and business/education partnership, offers student-centered Internet-based educational programs on renewable energy (including curricula, teachers' guides, and ordering information for solar parts and kits for experimentation); financial planning to purchase a PV system for a school or community; and coordinates resources from the federal government, state agencies, and local business partners. In SolarQuest's collaborative National Million Roofs Educational Initiative, to involve 5,000 schools from around the United States, each school partner will install a two-kilowatt photovoltaic (PV) system on their school building or on a building in their community.

Online, the Virtual SchoolHouse is a system to communicate information on all aspects of solar energy. The information is created by school administrators, teachers, and students around the world, who share their experience. In one proposed quest, several Mobile Solar Education Stations — electric buses with one-kilowatt of solar electric modules — travel to schools in New England, California, and Nevada to educate students. In another, students from the University of Massachusetts in Lowell installed a vaccine refrigerator, lights, and a radio transceiver powered by a PV system at a tiny medical post in the rural village of Malvas in Peru.

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Student who become members of the I-NetNews Team provide Internet news coverage of renewable energy events. Students are selected as members of the team from schools participating in SolarQuest.

During the summer of 1999, a team of 23 students from across the U.S., recruited by their churches, traveled to Uganda to install 100 solar-powered remote telecommunications systems to provide telephone, fax, and Internet access at schools as part of a collaborative effort between SolarQuest and the Solar Light for Churches of Africa program. Installations also included one at a Pygmy village in the mountains. SolarQuest's Allan Baer foresees district-wide programs in the Third World, where a satellite dish would be installed in one location and PV systems installed on however many schools were within a radius to connect to the satellite remotely.

U.S. students traveled to Uganda in 1999 to help install a solar-powered remote Internet connection at Ruhinda School. The wireless digital phonelink antenna connects to a computer with telephone modem, built-in fax software, and a normal telephone set. Here, in the classroom at Ruhinda School, Ugandan students learn how to connect to the Internet and send E-mails.

SolarQuest plans to expand this program to schools in 2000, where the students first would raise part of the money to pay for a solar electric system. A complete kit containing the PV modules, wiring, and all necessary parts–including complete assembly instructions–would be shipped to schools, where the students, probably as part of their science class, would assemble the package, test it, and then ship it overseas to a school without any electricity at all.

SolarQuest was created by EcoSage Corporation of Chelsea, Vermont. Contact Alan Baer, 1.802.685.3450. E-mail: aeb@solarquest.com. Website: solarquest.com.

High School Student Jumps into Solar on Both Coasts

Scott Goldman is a Washington, D.C., high school student profiled in the first volume of *Schools Going Solar* (April 1998) for his efforts to initiate an energy audit of his school and raise money to install solar panels on the school's roof.

Over the past two summers, Scott has served as an intern with the Los Angeles, California, Department of Water and Power's Solar Energy Program. Scott says that he learned of the internship through a family friend who was impressed with his commitment to solar energy.

At LADWP, Scott has worked on a variety of PV projects that include:

- Drafting marketing materials to promote the installation of solar panels in homes and businesses,
- Assisting in the installation of residential PV modules, and
- Helping the LADWP architect design a garage covered with solar panels.

Scott says that his internship was "a lot of fun. The best experience was learning how utilities operate."

Scott is now beginning his senior year at Georgetown Day High School. He has managed to raise moret than $20,000 toward his goal of installing solar panels on the school roof. This unexpected windfall has caused him to revise his plans. "I'd originally planned to install one kilowatt of PV," he said. "Now, I hope to stretch the money to cover four kilowatts, which is the average load for the student lounge." A solar-powered student lounge, he said, would be a very visible way of raising the student body's awareness of PV. Scott says he is consulting with his colleagues at LADPW on the plans for the solar student lounge.

When asked what his future plans were, Scott said that it was too early since he had not chosen a college or a major yet. He said he would always be interested in PV, but, like many other residents of the Washington area, he is "very interested in politics," and could not rule out a career in that area.

Solar Surfing—

Solar Power Resources on the Internet

School-Specific Resources

Alliance to Save Energy

www.ase.org/greenschools/

Educational initiative for energy efficiency in schools, includes curricula, teachers' lesson plans, and online forums for both students and teachers

American Electric Power's Solar Schools Project

http://www.aep.com/environment/solar/

Interactive site geared to students and created in large part by students in Ohio, with a link to the Bluffsview School Solar Project, with specifications and photos of their solar school installation

Energy Quest

www.energy.ca.gov/education/

Energy education from the California Energy Commission, including games, energy science projects, and lots of resources for parents and teachers

Energy $mart Schools

www.eren.doe.gov/energysmartschools/

A network of business and government partners promoting smart use of energy in schools, including teaching resources and success stories

Maryland's Solar Schools Program Plan

http://www.energy.state.md.us/executiv.htm#Plan

Includes a lot of background and technical information about photovoltaics, funding, installation, and curricula

On-Line Renewable Energy Education Module

http://solstice.crest.org/renewables/re-kiosk/index.shtml

An introductory course in renewables, including solar power, wind energy, small hydro, geothermal, and biomass, with brief explanations and case studies

Solar Energy: A Science Unit for Intermediate Grade Students

http://alpha.fsec.ucf.edu/ed/solar-unit/

A free science unit for teachers of intermediate grade students developed at the Florida Solar Energy Center

Solar Now

http://www.eren.doe.gov/solarnow/solarnow.htm

Project sponsored by the U.S. Department of Energy and created for kids to visit to learn more about solar energy

SolarQuest

www.solarquest.com

A student-oriented multifaceted web site with a "virtual schoolhouse" listing different solar energy "quests" contributed by school administrators, teachers, and students

Solar Schools

http://www.eren.doe.gov/solarschools/

Interstate Renewable Energy Council's program to bring solar energy to the coming generation of

consumers, educating them about what the technology can do, and how it helps the environment

Training Student Organizers Program

http://www.cenyc.org/HTMLEE/mainee.htm

Part of the environmental education initiative from the Council on the Environment of New York City

Watts on Schools

http://www.wattsonschools.com/

Chock-full of lessons and activities about solar as well as a growing collection of PV data as it is collected from the systems on schools in Texas, Arkansas, and Louisiana

Energy $mart Schools

The Energy $mart Schools partnership coordinates public and private efforts to build cost-effective, energy-efficient, and healthy schools and increase the use of clean energy technologies in both existing and planned schools. The resulting savings in energy bills will be used for educational needs.

This U.S. Department of Energy program also will increase student, teacher, and community awareness of energy and related issues, including financial management, air quality, climate change, and new technologies. DOE will serve as a clearinghouse for information and curricula, and will conduct demonstrations across the country to showcase energy audits, retrofits, alternative fuel school buses, modular classroom design, model new construction, and renewable technologies.

The UPVG and the Going Solar Campaigns are contributing partners to Energy $mart Schools.

For information: www.eren.doe.gov/energysmartschools/

General Resources

American Solar Energy Society

www.ases.org/solarguide/

Brightfields Initiative

http://www.eren.doe.gov/brightfields/

Explains the DOE program to use solar energy in communities to turn "brownfields" into "brightfields"

Center for Renewable Energy and Sustainable Technology (CREST)

solstice.crest.org

Centre for the Analysis and Dissemination of Demonstrated Energy Technologies Renewable Energy Center

www.caddet-re.org

Colorado Governor's Office of Energy Management & Conservation

www.state.co.us/oec

Energy Efficiency and Renewable Energy Network (DOE)

www.eren.doe.gov

Energy Information Administration (DOE)

www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/chap06.html

Florida Solar Energy Center (University of Central Florida)
www.fsec.ucf.edu

Interstate Renewable Energy Council/Photovoltaics for Utilities (PV4U)
www.irecusa.org

Million Solar Roofs Initiative
www.eren.doe.gov/millionroofs/

National Center for Photovoltaics
www.nrel.gov/ncpv

National Energy Education Development (NEED) Project
www.need.org/need

National Energy Information Center (DOE)
www.eia.doe.gov/neic/education/contents.htm

National Network of Energy and Environmental Education Professionals
www.leeric.lsu.edu/network/network.htm

National Renewable Energy Laboratory
www.nrel.gov/ceb.html

North Carolina Solar Center (North Carolina State University)
www.ncsc.ncsu.edu

Northeast Sustainable Energy Association
www.nesea.org

Solar Energy Industries Association
www.seia.org

Solar Energy Research and Education Foundation (SEREF)
www.seref.org

University Center of Excellence for Photovoltaics Research and Education (DOE/Georgia Institute of Technology)
www.ece.gatech.edu/research/UCEP

U.S. Department of Energy Regional Support Offices:

Atlanta, Georgia: *www.eren.doe.gov/aro/*

Boston, Massachusetts: *www.eren.doe.gov/bro/*

Chicago, Illinois: *www.eren.doe.gov/cro/*

Denver, Colorado: *www.eren.doe.gov/dro/*

Philadelphia, Pennsylvania: *www.eren.doe.gov/pro/*

Seattle, Washington: *www.eren.doe.gov/sro/*

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www.upvg.org

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1-800-72-ENERGY
www.energy.state.md.us

Utility PhotoVoltaic Group (UPVG)
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Washington, DC 20036-5802
202-857-0898
202-223-5537 fax
E-mail: upvg@ttcorp.com
Website: www.upvg.org

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